skirted Nova Scotia close to the southward. On the morning of the 30th it crossed southeastern Newfoundland and late in the day merged with an extratropical cyclone in the high latitudes of the North Atlantic.

Relative to this disturbance, an advisory warning was issued by the Forecast Center at Jacksonville at 10 a. m. of the 27th, and storm warnings were ordered hoisted on the 28th from the Virginia Capes to Eastport, Maine. The latter order was issued by the Washington Forecast Center.

Disturbance of September 30–October 3, 1937.—(Track VI.) Slightly threatening conditions appeared over the southern part of the Gulf of Mexico and the western Caribbean Sea on the afternoon of September 30, with some evidences of cyclonic circulation centered a little south of the Yucatan Channel.

At 6 a. m., local time, of October 1 the center of the condition appeared to be at approximately 23½° N., 86° W. No wind exceeding force 6 occurred there during the day. The center moved very slowly northwestward between 6 a. m. and 6 p. m., but with much greater rapidity from then until the morning of October 2, when it lay near 27½° N., 91° W. The Honduran steamer *Morazan* reported a barometer of 29.62, wind southeast force 3, near this position. This pressure reading is the lowest of record in connection with the disturbance.

The center of the LOW continued to move toward the northwestward until the night of the 2d, when it turned

toward the north and entered the Louisiana coast at Atchafalaya Bay at about noon of the 3d.

Only one report of a gale wind connected with the disturbance in mid-Gulf is now at hand. This was experienced by the American steamer *Gulfprince*, from east-southeast, force 8, barometer 29.93, in 26°36′ N., 88°12′ W. at 7 a. m., local time, of October 2, at a considerable distance to the eastward of the center at that time. It may be mentioned, however, that at about 9 p. m. of September 30 the American steamer *Seminole* reported a northeast gale of force 8 in the vicinity of 27° N., 88° W., at that time far to the northward of the center of the unsettled area. On October 1, it may be mentioned further, a second LOW of some energy showed signs of developing in the Yucatan Channel, and at about noon, local time, the Honduran schooner *Racer* reported a gale of force 10 off the western end of Cuba. This secondary LOW deteriorated rapidly, however, and later merged with the primary LOW to the northward.

From late on September 30, until the principal LOW went inland in Louisiana on October 3, frequent advisory messages were issued by the forecaster at New Orleans. On October 1 storm warnings were ordered along the coast from Panama City, Fla., to Morgan City, La., and were extended at night as far eastward as Carrabelle, Fla., and on the 2d from Carrabelle to Port O'Connor, Tex. All warnings were lowered on the 3d.

NOTES AND REVIEWS

Note on H. C. Huang's Investigations of Frontogenesis in the North Pacific. By PAT J. HARNEY. Two years ago R. W. Richardson presented the results of his study of storm tracks and their relation to the frontal zones and to the distribution of air masses over the North Pacific Ocean before the Association of Pacific Coast Geographers at Los Angeles. His curves of "cyclone frequency" were subsequently published in the MONTHLY WEATHER REVIEW in his article "Winter Air Mass Convergence in the North Pacific." [1]

These curves have recently been used in checking the calculated position of the Polar Front over the North Pacific by H. C. Huang of the National Central University of Nanking, China. While a graduate student of the California Institute of Technology, Huang determined the regions of frontogenesis over the North Pacific in the manner developed by Petterssen; [2] the results form part of a thesis at the California Institute and will subsequently be published by the National Research Institute of Meteorology at Nanking, China. The object of this note is to call attention to the results of these two studies of weather over the North Pacific, which give a useful check on the theoretical methods advanced by Petterssen.

For answering some of the questions on the location of the Polar Front in the Far East two of the charts for the winter season from his paper, Frontogenesis in the Far East, are here reproduced.

A brief comment on the method may be appropriate. Starting from the concept that frontogenesis will occur where the motion is such as to increase the concentration of iso-alpha lines (here representing temperature) until a marked discontinuity exists, the formula correlating the motion of the air and the properties of the iso-alpha field, as developed by Petterssen, may be written,

$$F = a(\cos 2\psi - \cos 2\psi') |\nabla \alpha|$$

where F, the frontogenetical function, is a product of a, the dilatation term of the field of motion (in which ψ is the angle a tangent to the isotherms makes with the dilatation axis or deformation axis of outflow and ψ' is the angle the line $F=0$ makes with the dilatation axis) and $|\nabla \alpha|$, the magnitude of the ascendant of the property α.

To evaluate the function F over the North Pacific, Huang combined the streamlines constructed by W. Werenskiold, [3] for this season with the surface-wind data available from his country, and located the hyperbolic streamline patterns which indicated the existence of the deformation fields shown on figure 1. The superposed isothermal field gave values of $|\nabla \alpha|$, which together with the graphically determined terms above listed were used to plot a field of F. The line of frontogenesis found on figure 2 represents the maximum of this field of F.

In discussing this line of frontogenesis Huang says:

* * * the region of maximum cyclone frequency is quite far removed from the Pacific Polar Front as determined by V. Bjerknes and his coauthors in the book *Physikalische Hydrodynamik.* Actually Richardson's diagram places the storm tracks along the computed frontogenetic line given above, rather than along the deformation axis indicated in the above reference. These two lines represent different things and do not necessarily have to follow each other closely. The deformation axis is formed by the field of motion only, while the frontogenetic line is determined from the frontogenetic function F * * * which has the real importance in determining the zone of frontal activity.

When the two are not coincident with each other as is the case when the maximum $|\nabla \alpha|$ zone does not fall along the deformation axis, or when the angle is such that it does not give a large positive value of F along the axis, the actual frontal activity or the resultant cyclone tracks cannot coincide with the deformation axis of the field of motion. This is just what happens over the Pacific Ocean in the winter season when the cyclonic tracks and the deformation axis denoted in *Physikalische Hydrodynamik* are quite widely separated. The characteristics and the real importance of a frontogenetic line are thus further established by this interesting example.

[1] MONTHLY WEATHER REVIEW, vol. 64, No. 6, pp. 109–203, June 1936.
[2] Contribution to the Theory of Frontogenesis, Sverre Petterssen, Geofysiske Publikationer, vol. XI, No. 6, Oslo 1936.
[3] Mean Monthly Air Transport over the North Pacific Ocean, W. Werenskiold, Geofysiske Publikationer, Vol. II, No. 9, Oslo 1922.
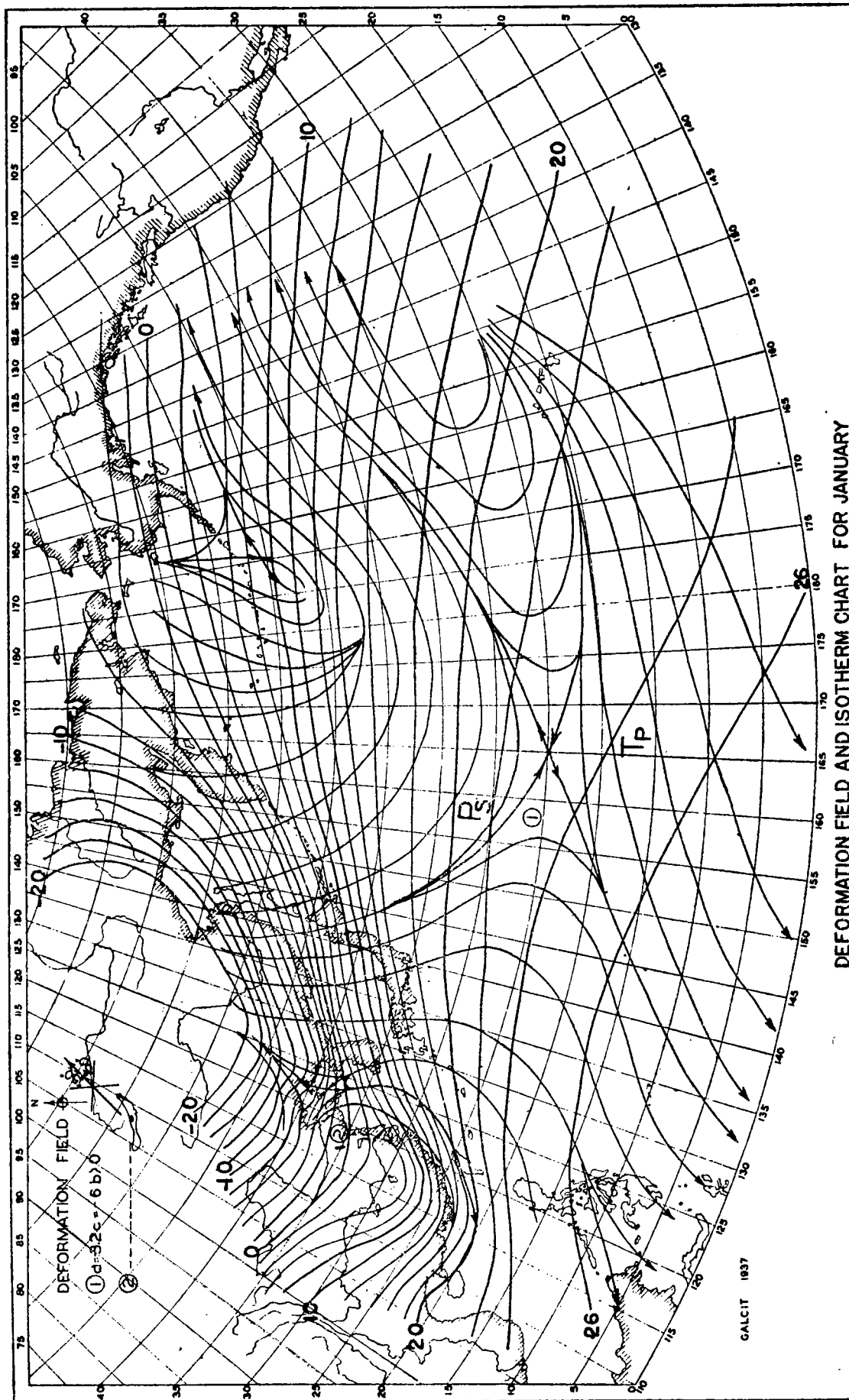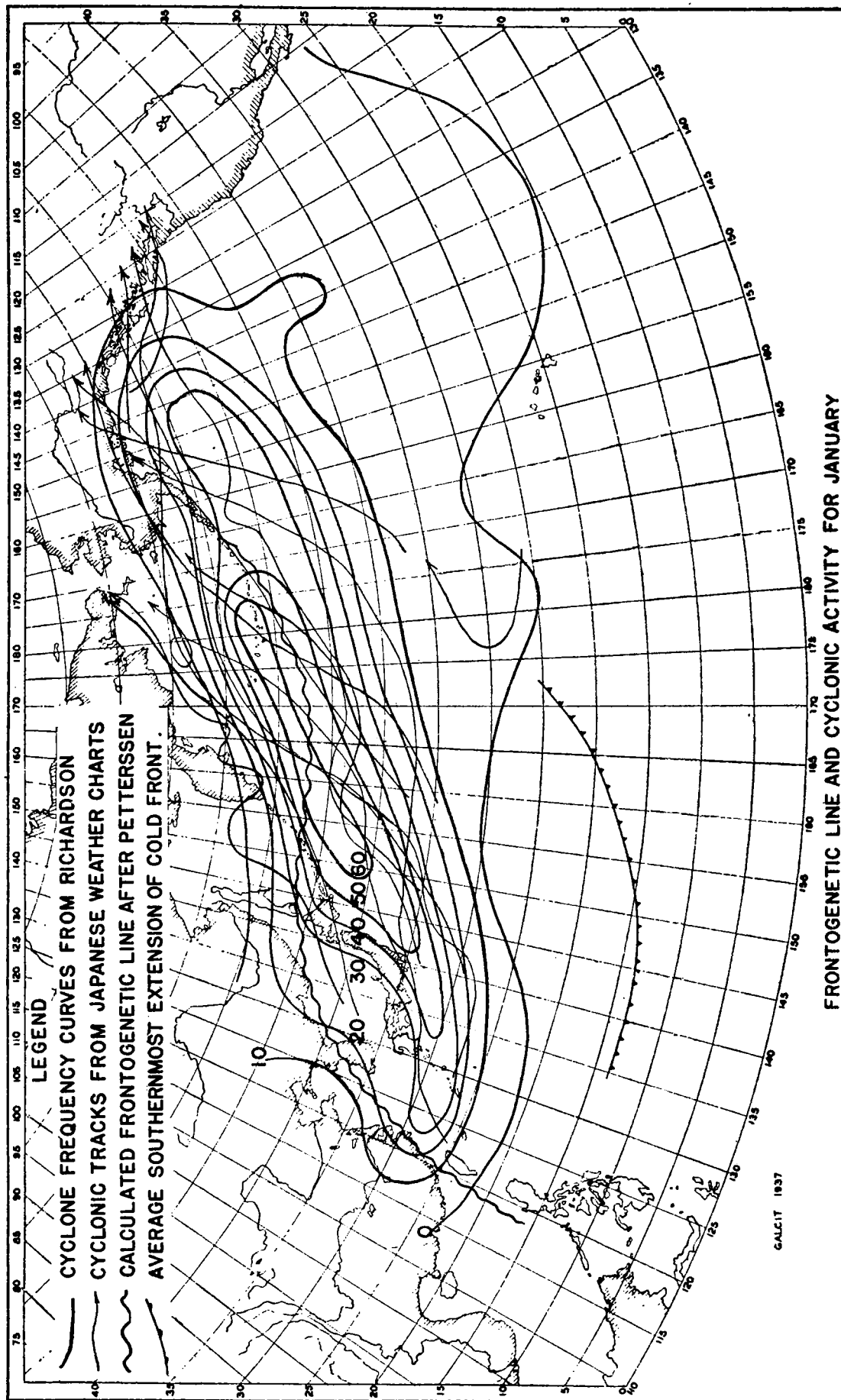
DEFORMATION FIELD AND ISOTHERM CHART FOR JANUARY

FIGURE 1

LEGEND

CYCLONE FREQUENCY CURVES FROM RICHARDSON

CYCLONIC TRACKS FROM JAPANESE WEATHER CHARTS

CALCULATED FRONTOGENETIC LINE AFTER PETTERSSEN
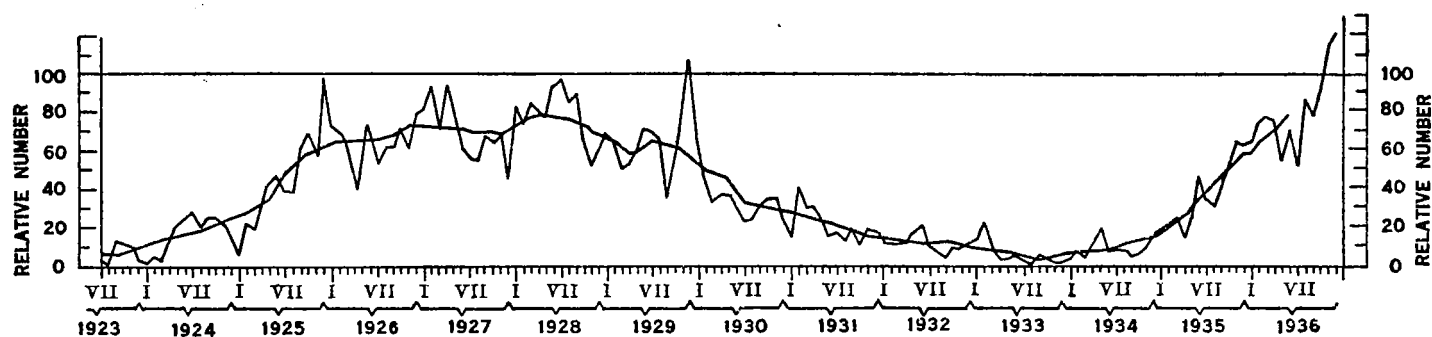
AVERAGE SOUTHERNMOST EXTENSION OF COLD FRONT.

FRONTOGENETIC LINE AND CYCLONIC ACTIVITY FOR JANUARY

FIGURE 2

GALCIT 1937

Monthly Observed Sunspot Relative Numbers for the Period 1920–36, inclusive.

By Charles M. Lennahan.

The definitive monthly sunspot relative numbers for the period 1749–1924, inclusive, have been published in Terrestrial Magnetism and Atmospheric Electricity, 30: 83–86, June 1925. They are also available in the Monthly Weather Review, 30: 171–176, April 1902 for 1749–1901, and 48: 459–461, August 1920, for 1901–1919, all dates inclusive.

The table published herewith is based on data taken from *Astronomische Mitteilungen*, Nrs. CXII–CXXXV, inclusive, and brings the data, as published in the Monthly Weather Review, up to date.[1] The monthly relative numbers in the table do not agree exactly with the values published regularly in the Monthly Weather Review inasmuch as the latter are provisional and are based only on observations made at Zürich and Arosa, whereas supplementary observations from other stations were used in computing the present values.

synoptic meteorology, with especial reference to aeronautical meteorology. A knowledge of elementary general meteorology is presupposed; but discussions are included of topics in physical and dynamical meteorology that are essential to a proper background for practical work in air-mass analysis.

The first two chapters discuss briefly the distribution of temperature in the earth's atmosphere—especially the vertical distribution—and its dependence on solar and terrestrial radiation; vertical stability and instability in the atmosphere; vertical motions and the phenomena of condensation and precipitation which accompany them; and the theory and use of various thermodynamic diagrams. The third chapter is devoted to a general discussion of the nature and characteristics of air masses, and is followed by chapters on the general circulation and on cyclones and anticyclones from the viewpoint of air-mass analysis. After a chapter on the changes which occur in air masses as a result of lifting, Willett's system of classi-

Observed and smoothed monthly relative numbers 1923–36.

The graph shows the curve corresponding to the observed values, together with the superimposed curve of the smoothed values. The smoothed values are obtained by first taking the mean of each set of 12 successive monthly numbers, and then the mean of each pair of successive monthly numbers, and then the mean of each pair of successive values so obtained; the result is taken to be the smoothed monthly sunspot relative number for the 7th month in the set of 12 corresponding to the first of the pair of values.

fication of the air masses of North America is presented. The practical analysis of synoptic maps is next discussed, with several illustrative examples; and is followed by a chapter on weather forecasting, which includes an account of Petterssen's kinematical methods. Succeeding chapters cover the subjects of condensation and precipitation; fog; and the thunderstorm, tornado, and waterspout. Discussions of the formation of ice on aircraft, atmospheric turbulence and its effects, recent summaries of upper air wind data for the United States, and duststorms complete the book.—*Edgar W. Woolard.*

Monthly observed sunspot relative numbers

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
1920	51.1	53.9	70.2	14.8	33.3	38.7	27.5	19.2	36.3	49.6	27.2	29.9	37.6
1921	31.5	28.3	26.7	32.4	22.2	33.7	41.9	22.8	17.8	18.2	17.8	20.3	26.1
1922	11.8	26.4	54.7	11.0	8.0	5.8	10.9	6.5	4.7	6.2	7.4	17.5	14.2
1923	4.5	1.5	3.3	6.1	3.2	9.1	3.5	0.5	13.2	11.6	10.0	2.8	5.8
1924	0.5	5.1	1.8	11.3	20.8	24.0	28.1	19.3	25.1	25.6	22.5	16.5	16.7
1925	5.5	23.2	18.0	31.7	42.8	47.5	38.5	37.9	60.2	69.2	58.6	98.6	44.3
1926	71.8	70.0	62.5	38.5	64.3	73.5	52.3	61.6	60.8	71.5	60.5	79.4	63.9
1927	81.6	93.0	69.6	93.5	79.1	59.1	54.9	53.8	68.4	63.1	67.2	45.2	69.0
1928	83.5	73.5	85.4	80.6	76.9	91.4	98.0	83.8	89.7	61.4	50.3	59.0	77.8
1929	68.9	64.1	50.2	52.8	58.2	71.9	70.2	65.8	34.4	54.0	81.1	108.0	65.0
1930	65.3	49.2	35.0	38.2	36.8	28.8	21.9	24.9	32.1	34.4	35.6	25.8	35.7
1931	14.6	43.1	30.0	31.2	24.6	15.3	17.4	13.0	19.0	10.0	18.7	17.8	21.2
1932	12.1	10.6	11.2	11.2	17.9	22.2	9.6	6.8	4.0	8.9	8.2	11.0	11.1
1933	12.3	22.2	10.1	2.9	3.2	5.2	2.8	0.2	5.1	3.0	0.6	0.3	5.7
1934	3.4	7.8	4.3	11.3	19.7	6.7	9.3	8.3	4.0	5.7	8.7	15.4	8.7
1935	18.9	20.5	23.1	12.2	27.3	45.7	33.9	30.1	42.1	53.2	64.2	61.5	36.1
1936	62.8	74.3	77.1	74.9	54.6	70.0	52.3	87.0	76.0	89.0	115.4	123.4	80.4

Horace R. Byers. *Synoptic and Aeronautical Meteorology.* New York, McGraw-Hill Book Co., 1937.

The primary purpose of this book is to provide a text on air-mass analysis and its practical applications in

BIBLIOGRAPHY

[Richmond T. Zoch, in Charge of Library]

By Amy D. Putnam

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

American radio relay league.

The radio amateur's handbook. West Hartford, Conn. 14th ed. [c1936]. 536 p. incl. front., illus., ports., diagrs. 24½ cm.

Berger, P.

Le caoutchouc des ballons-pilotes aux points de vue physique et chimique. Zürich. p. 372–388. figs., tables. 23½ cm. [At head of title: Tirage apart de Helvetica physica acta, vol. IX, fasciculus quintus.]

—— Réglement du contrôle des records d'altitude. Paris. 1935. p. 61–68. tables, diagrs. 26½ cm. (Photostated.) [At head of title: Fédération aéronautique internationale. Paris. Publication trimestrielle. 16e année no. 60. Janvier. 1935.]

[1] The numbers published in the Monthly Weather Review 53: 77, February 1925 are not definitive values.